



**REPRODUCING DEVICE AND METHOD,  
RECORDING MEDIUM AND PROGRAM**

CROSS REFERENCES TO RELATED APPLICATIONS

5 [0001]

The present document is based on Japanese Priority Document JP 2003-101582, filed in the Japanese Patent Office on April 4, 2003, the entire contents of which being incorporated herein by reference.

10

BACKGROUND OF THE INVENTION

[0002]

1. Field of the Invention

[0003]

15 The present invention relates to a reproducing device and method, and a recording medium and a program, for example, which are suitable for use in reproducing video data recorded on an information recording medium, such as an optical disc at high speed.

20 [0004]

2. Description of Related Art

[0005]

In recent years, information recording media, such as optical discs, having a remarkably improved recording rate have been put into practical use. On such information recording media, video data can be recorded for a long time with relatively high-quality.

25 [0006]

The applicant of the present invention has already  
30 proposed a method of recording high-resolution video data

and low-resolution video data on an optical disc for the same image contents. In this method, the low-resolution video data are used for editing and the like (for example, see patent Document 1 listed below).

5 [0007]

Herein, a case where images of video data recorded on an information recording medium are reproduced at high speed so that an operator finds a desired scene is considered.

10 [0008]

For example, if video data recorded on a conventional, linearly accessible, magnetic cassette tape or the like are reproduced at high speed by a VCR (Video Cassette Recorder), reproduction speed gradually changes so that the display time for each frame is reduced as compared with normal playback (normal reproduction). As a result, the operator can quickly find the desired scene.

[0009]

20 On the other hand, if video data recorded on a non-linearly accessible information recording medium such as an optical disc, a magnetic disk or a semiconductor memory are reproduced by a DVD player or the like, reproduction speed is generally instantaneously increased to display images while skipping frames in a similar way to show picture cards; that is, a group of images are extracted in number in accordance with the reproduction speed so that the extracted images are displayed as static or still images for a predetermined period of  
25  
30 time. In addition, another method in high-speed playback

(high-speed reproduction) has been devised. According to this method, the above-mentioned low-resolution video data are used to reduce the amount of time required to decode video data so as to increase the number of images to be displayed and to reduce the number of skipped images.

[0010]

[Patent Document 1]

Japanese Patent Application Publication Hei 11-136631

10 [0011]

In a case where video data recorded on a non-linearly accessible information recording medium are reproduced at high speed, reproduction speed is instantaneously changed by any of the conventionally existing methods. Therefore, there is a problem that an operator feels uncomfortable to see the reproduced images.

[0012]

Moreover, since some images are skipped without being displayed, the operator may sometimes disadvantageously miss a desired scene.

#### SUMMARY OF THE INVENTION

[0013]

In view of the above-described background, the present invention is devised to reproduce video data recorded on a non-linearly accessible information recording medium at high speed without giving any uncomfortable feelings to an operator.

[0014]

30 A reproducing device according to the present

invention includes: setting means for setting a reproduction speed of the video data at a predetermined acceleration; readout means for reading out the video data from the information recording medium; and  
5 generation means for combining a plurality of images of the video data read out by the readout means in accordance with the reproduction speed set by the setting means so as to generate an output image for high-speed playback.

10 [0015]

The generation means can extract and combine band-shaped parts from the number of images corresponding to the reproduction speed set by the setting means, respectively, so as to generate the output image for the  
15 high-speed playback.

[0016]

First video data at a high bit rate and second video data at a lower bit rate than that of the first video data for the same material are recorded on the  
20 information recording medium. The readout means can read out the second video data from the information recording medium.

[0017]

The first and second video data can be  
25 intermittently recorded on the physically same track of the information recording medium.

[0018]

At the transition from high-speed playback using the second video data to low-speed playback (low-speed  
30 reproduction) using the first video data, an acceleration

in accordance with the time required to read out and decode the first video data can be calculated so as to perform deceleration at a deceleration corresponding to, that is, equal to, the calculated acceleration.

5 [0019]

At the transition from low-speed playback using the first video data to high-speed playback using the second video data, an acceleration in accordance with the time required to read out and decode the second video data can be calculated so as to perform acceleration at the  
10 calculated acceleration.

[0020]

When acceleration and deceleration are terminated so as to perform normal-speed playback, a screen can have a  
15 fixed arrangement in accordance with a speed at the time, regardless of the process of acceleration and deceleration.

[0021]

A reproducing method according to the present  
20 invention includes the steps of: setting a reproduction speed of the video data depending upon a predetermined acceleration; reading out the video data from an information recording medium; and combining a plurality of images of the video data read out by the process at  
25 the readout step in accordance with the reproduction speed set by the process at the setting step so as to generate an output image for high-speed playback.

[0022]

A program of a recording medium according to the  
30 present invention includes the steps of: setting a

reproduction speed of the video data depending upon a predetermined acceleration; reading out the video data from an information recording medium; and combining a plurality of images of the video data read out by the process at the readout step in accordance with the reproduction speed set by the process at the setting step so as to generate an output image for high-speed playback.

[0023]

A program according to the present invention makes a computer execute a process including the steps of: setting a reproduction speed of the video data depending upon a predetermined acceleration; reading out the video data from an information recording medium; and combining a plurality of images of the video data read out by the process at the readout step in accordance with the reproduction speed set by the process at the setting step so as to generate an output image for high-speed playback.

[0024]

In the reproducing device and method and the program according to the present invention, a reproduction speed of video data is set depending upon a predetermined acceleration. A plurality of images of the read out video data is combined in accordance with the set reproduction speed so as to generate an output image for high-speed playback.

[0025]

As described above, according to the present invention, video data recorded on a non-linearly accessible information recording medium can be searched without giving any uncomfortable feelings to an operator,

as if the video data were reproduced from a linear recording medium.

[0026]

Since the reproduction speed is represented by the  
5 number of horizontal bands on a screen, the acceleration,  
the speed and the relative position on a medium can be  
intuitively recognized so as to remarkably increase the  
operationality of a search. Since a search image looks  
natural without giving any shocks, the image is eye-  
10 friendly for the operator.

[0027]

At the transition to shuttle playback, a still image  
or a single-speed reproduced image is displayed until  
data for a shuttle image are read so as to be decoded.  
15 The amount of time required to read out and decode the  
data can be reduced or eliminated. Moreover, at the  
transition from shuttle playback to normal playback, a  
still image or a single-speed reproduced image is  
displayed until data for a main track image are read out  
20 and decoded. The amount of time required to read and  
decode the data can be reduced or eliminated so as to  
reduce the number of unsightly images.

[0028]

In a steady state, i.e., a state without any  
25 acceleration or deceleration, display is performed in the  
same layout regardless of the process of acceleration and  
deceleration. Therefore, the screen is comfortable to  
see. Moreover, the speed can be easily recognized.

[0029]

30 If low resolution data have a commonality in format,

only a slight parameter change allows the application of the present invention to any main track image systems.

#### BRIEF DESCRIPTION OF THE DRAWINGS

5 [0030]

The above and other objects, features and advantages of the present invention will become more apparent from the following description of the presently preferred exemplary embodiments of the invention taken in conjunction with the accompanying drawings, in which:

[0031]

Fig. 1 is a block diagram showing an exemplary configuration of a disc recording/reproducing device with the application of the present invention;

15 [0032]

Fig. 2 is a diagram showing an example of a recording format of an optical disc;

[0033]

Fig. 3 is a block diagram showing an exemplary configuration of a PCI interface for a verification process;

[0034]

Fig. 4 is a flowchart for illustrating the verification process;

25 [0035]

Fig. 5 is a diagram showing an example of the verification process in a case where a recording rate of a disc drive is single speed;

[0036]

30 Fig. 6 is a diagram showing an example of the



verification process in a case where a recording rate of  
the disc drive is double speed;

[0037]

Fig. 7 is a diagram showing an example of time-shift  
5 playback in a case where a recording rate of the disc  
drive is single speed;

[0038]

Fig. 8 is a diagram showing an example of time-shift  
playback in a case where a recording rate of the disc  
10 drive is double speed;

[0039]

Fig. 9 is a block diagram showing an exemplary  
configuration of a PCI interface for an upload process;

[0040]

15 Fig. 10 is a diagram showing an example of the  
upload process;

[0041]

Fig. 11 is a flowchart for illustrating a writing  
process for realizing the upload process in combination  
20 with a transmission process;

[0042]

Fig. 12 is a flowchart for illustrating a data  
storage process at a step S14 in Fig. 11;

[0043]

25 Fig. 13 is a flowchart for illustrating a data  
readout process at a step S17 in Fig. 11;

[0044]

Fig. 14 is a flowchart for illustrating the  
transmission process for realizing the upload process in  
30 combination with the writing process;

[0045]

Fig. 15 is a diagram for illustrating set values of frequency limit and exhaustion limit in the upload process;

5 [0046]

Fig. 16 is a diagram for schematically illustrating high-speed playback by a conventional DVD player or the like;

[0047]

10 Fig. 17 is a diagram for schematically illustrating high-speed playback by the disc recording/reproducing device according to the embodiment of the present invention;

[0048]

15 Fig. 18 is a diagram for schematically illustrating a process at the transition from high-speed playback to normal-speed playback;

[0049]

20 Fig. 19 is a diagram for schematically illustrating a horizontal division of a screen in high-speed playback;

[0050]

25 Fig. 20 is a diagram showing an example of adjustment of the division of the screen when the reproduction speed reaches a target reproduction speed in high-speed playback;

[0051]

30 Fig. 21 is a diagram showing an example of adjustment of the division of the screen when a reproduction mode returns from high-speed playback to normal-speed playback; and

[0052]

Fig. 22 is a flowchart for illustrating a high-speed playback process.

5 DESCRIPTION OF THE PREFERRED EMBODIMENT

[0053]

Hereinafter, a preferred embodiment of the present invention will be described. In order to clarify the correlation between each means of the invention recited  
10 in the appended claims and the following embodiment, the features of the present invention will be described below in such a manner that each means is followed by a corresponding component in the foregoing embodiment in parentheses (only one example for each means).

15 [0054]

Specifically, a reproducing device according to the present invention (for example, a disc recording/reproducing device shown in Fig. 1) includes: setting means for setting a reproduction speed of video  
20 data at a predetermined acceleration (for example, a process at a step S52 shown in Fig. 22, executed by a system controller 10 shown in Fig. 1); readout means for reading out the video data from an information recording medium (for example, a disc drive 2 shown in Fig. 1); and  
25 generation means for combining a plurality of images of the video data read out by the readout means in accordance with the reproduction speed set by the setting means so as to generate an output image for high-speed playback (for example, a process at a step S53 shown in  
30 Fig. 22, executed by an OSD section 8 shown in Fig. 1).

[0055]

Fig. 1 shows an exemplary configuration of a disc recording/reproducing device according to an embodiment to which the present invention is applied. The disc recording/reproducing device encodes an input video signal at two image qualities, that is, at a high or standard resolution and a lower resolution, by a predetermined encoding method. The resulting high bit-rate encoded data (at a high resolution or a standard resolution) and low bit-rate encoded data (at a low resolution) are recorded/reproduced on/from an optical disc 1.

[0056]

The high bit-rate encoded data are decoded so as to be provided for a user in normal playback. Hereinafter, the high bit-rate encoded data are also referred to as main track data. On the other hand, the low bit-rate encoded data are decoded so as to be provided for a user in, for example, high-speed playback or editing. Hereinafter, the low bit-rate encoded data are also referred to as low resolution data.

[0057]

The optical disc 1 can be inserted into and removed from the disc drive 2. In accordance with control by a drive control section 14 of the system controller 10, the disc drive 2 records the main track data or the low resolution data supplied from a PCI (Peripheral Component Interconnect) interface 3 on the optical disc 1 inserted into the disc drive 2 with a built-in pickup 2A. The disc drive 2 also reads out the main track data or the

low resolution data recorded on the optical disc 1 with the pickup 2A so as to supply them to the PCI interface 3.

[0058]

The PCI interface 3 includes a buffer 31 (Fig. 3) therein and acts as an interface between the disc drive 2 and one of a main decoder 4, a low resolution decoder 5, a main encoder 15 and a low resolution encoder 17.

[0059]

For example, the PCI interface 3 supplies the main track data supplied from the disc drive 2 to the main decoder 4 while supplying the low resolution data similarly supplied from the disc drive 2 to the low resolution decoder 5. The PCI interface 3 also supplies the low resolution data supplied from the disc drive 2 to a transmission section 18.

[0060]

The PCI interface 3 also acts as an interface between the disc drive 2 and the main encoder 15 or the low resolution encoder 17 so as to supply the main track data supplied from the main encoder 15 to the disc drive 2 while supplying the low resolution data supplied from the low resolution encoder 17 to the disc drive 2.

[0061]

In this embodiment, a play list produced by non-destructive editing or the like can also be recorded on the optical disc 1. If the play list is recorded on the optical disc 1, the play list is read out from the optical disc 1 by the disc drive 2. Then, the readout play list is supplied to a controller 11 through the PCI interface 3. Furthermore, as described below, meta data

or a time code is also recorded on the optical disc 1.  
The meta data or the time code is read out from the  
optical disc 1 by the disc drive 2 so as to be supplied  
to the controller 11 through the PCI interface 3.

5 [0062]

The main decoder 4 includes a buffer 4A in which the  
main track data supplied from the PCI interface 3 are  
temporarily stored. The main decoder 4 performs, for  
example, MPEG-decoding on the main track data stored in  
10 the buffer 4A in accordance with the control of a main  
decoder control section 13 of the system controller 10.  
Then, the main decoder 4 supplies the resulting high-  
resolution or standard-resolution video data (hereinafter,  
also referred to as main track video data) to a switch 7.  
15 The main decoder 4 also supplies a ready flag, which  
indicates a ready state of an output of video data  
obtained by decoding the main track data supplied from  
the PCI interface 3, to the switch 7 and the main decoder  
control section 13.

20 [0063]

In this case, the ready flag is, for example, a 1-  
bit flag. If the output of video data by the main  
decoder 4 is ready, the value of the ready flag is set to,  
for example, 1. If not, the value of the ready flag is  
25 set to, for example, 0.

[0064]

The ready flag indicates an output preparation state  
of the main track data in a broad manner. Therefore, it  
is apparent that a state where the main decoder 3 is  
30 decoding a picture instead of decoding another picture

that should be decoded is included in the output preparation state. In addition, a state where an error occurs in the main track data to prevent a picture from being decoded is also included in the output preparation  
5 state.

[0065]

The low resolution decoder 5 includes a buffer 5A in which the low resolution data supplied from the PCI interface 3 are temporarily stored. Then, the low  
10 resolution decoder 5 decodes the low resolution data stored in the buffer 5A by a predetermined method in accordance with the control of a low resolution decoder control section 12 of the system controller 10. Then, the low resolution decoder 5 supplies the resulting video  
15 data at a low resolution (hereinafter, also referred to as low resolution video data) to a resize section 6.

[0066]

The resize section 6 is configured with poly-phase filters at, for example, 5:2 (3:1 in a case of PAL (Phase  
20 Alternation by Line) by 11:4. The resize section 6 thins out horizontal lines of the low resolution data corresponding to progressive video data, in which one frame is composed of 30 horizontal lines, so as to generate interleaved video data, in which one frame is  
25 composed of 60 horizontal lines. Furthermore, the resize section 6 interpolates pixels of the video data and the like so as to generate video data having the same size (the same number of pixels) as that of the main track video data output from the main decoder 4 (hereinafter,  
30 also referred to as resized video data). Then, the

resize section 6 supplies the thus generated video data to the switch 7.

[0067]

The switch 7 selects one of the main track video data output from the main decoder 4 and the resized video data output from the resize section 6 in accordance with the ready flag supplied from the main decoder 4 so as to output the selected one to the OSD (On Screen Display) section 8. The switch 7 also selects one of the main track video data output from the main decoder 4 and the resized video data output from the resize section 6 in accordance with the control from the controller 11 so as to supply the selected one to the OSD section 8. Therefore, in the embodiment shown in Fig. 1, the selection of one of the main track video data and the resized video data to be output by the switch 7 can be made not only by the ready flag but also by the control from the controller 11.

[0068]

The OSD section 8 superimposes information such as a time code on the video data supplied from the switch 7 as needed so as to supply it to a scan converter 9. The scan converter 9 converts a scanning method of the video data supplied from the OSD section 8 as needed so as to supply it to a display 22. The OSD section 8 includes a buffer for storing the video data supplied from the switch 7. In high-speed playback, the OSD section 8 combines a plurality of video data obtained by decoding the low resolution data supplied from the switch 7 in accordance with the control from the system controller 10



so as to output the combined video data to a later stage.  
A process in the high-speed playback will be described  
below with reference to Fig. 16 and the subsequent  
drawings.

5 [0069]

The controller 11; the low resolution control  
section 12; the main decoder control section 13; and a  
drive control section 14 constitute the system controller  
10. The system controller 10 controls each of the blocks  
10 constituting the device.

[0070]

More specifically, the controller 11 receives an  
operating signal supplied by manipulation of a remote  
commander (or a remote controller) 21 by a user, and the  
15 play list, the time code or the meta data supplied from  
the PCI interface 3 so as to control the switch 7 or the  
low resolution decoder control section 12 in accordance  
with the operation signal, the play list, the time code,  
the meta data or the like.

20 [0071]

The low resolution decoder control section 12  
controls the low resolution decoder 5 and the drive  
control section 14 in accordance with the control from  
the controller 11.

25 [0072]

The main decoder control section 13 monitors the  
control on the low resolution decoder 5 by the low  
resolution decoder control section 12 and controls the  
main decoder 4 and the drive control section 14 so as to  
30 follow the control.

[0073]

The drive control section 14 is configured with, for example, a file system and a device driver. The drive control section 14 controls the disc drive 2 in  
5 accordance with the control from the low resolution decoder control section 12 and the main decoder control section 13.

[0074]

The main encoder 15 encodes video data, which are  
10 input so as to be recorded, at a predetermined high bit rate by a MPEG-encoding method or the like. Then, the main encoder 15 outputs the resulting main track data to the PCI interface 3. A resize section 16 performs a reverse process to that performed by the resize section 6  
15 on the video data which are input so as to be recorded. The resize section 16 outputs the resulting progressive video data, in which one frame is composed of 30 horizontal lines, to the low resolution encoder 17. The low resolution encoder 17 encodes the video data input  
20 from the resize section 16 by a JPEG (Joint Photographic Coding Experts Group) encoding method or the like at a predetermined bit rate lower than the bit rate of encoding by the main encoder 15. Then, the low resolution encoder 17 outputs the resulting low  
25 resolution data to the PCI interface 3.

[0075]

The remote commander 21 outputs, for example, an infrared ray operating signal in accordance with the manipulation by a user. The display 22 displays the  
30 video data supplied from the scan converter 9.

[0076]

In the embodiment shown in Fig. 1, for example, the system controller 10 can be configured with a software, whereas the blocks other than the system controller 10  
5 can be configured with dedicated hardwares, respectively. Moreover, for example, the main decoder 4, the low resolution decoder 5, the resize section 6, the switch 7, the main encoder 15, the resize section 16, the low resolution encoder 17 and the like can be configured by  
10 making a DSP (Digital Signal Processor) or the like execute a program. Furthermore, the system controller 10 may be configured with a dedicated hardware instead of a software.

[0077]

15 In the disc recording/reproducing device shown in Fig. 1, the recording or reproducing is performed on the optical disc 1. However, information recording media other than the optical disc, for example, a magnetic disk, a magneto-optical disc or a magnetic tape, may also be  
20 used for recording or reproducing data.

[0078]

Next, Fig. 2 shows a recording format of the optical disc 1.

[0079]

25 The optical disc 1 is, for example, a CLV (Constant Linear Velocity) system optical disc. A track of the optical disc 1 is divided into a plurality of sectors. Furthermore, a cluster corresponding to a unit of reading/writing data from/on the optical disc 1 is  
30 composed of at least one sector. In this case, the

cluster can be composed of, for example, a 64-kilobyte recording area or the like.

[0080]

As described above, the main track data and the low  
5 resolution data corresponding to the main track data are recorded on the optical disc 1. The main track data and the low resolution data are intermittently recorded in units of a predetermined amount of time, for example, 1.5 to 2 seconds, of the original video data (video data  
10 before being encoded) or in units of a predetermined amount of the original data.

[0081]

More specifically, assuming that a predetermined unit containing the main track data and the low  
15 resolution data for a predetermined period of time of the original video data or a predetermined amount of the original video data is referred to as a carton, the main track data and the low resolution data are recorded for each carton on the optical disc 1 as shown in Fig. 2. In  
20 consideration of data recording on the CLV system optical disc 1, high-speed playback (so-called shuttle playback), data concealment, eject time of the optical disc 1 and the like, it is suitable that the main track data to be contained in each carton correspond to, for example, 1.5  
25 to 2 seconds of the original video data, as described above.

[0082]

The carton is composed of, for example, as shown in Fig. 2, the low resolution data and the main track data,  
30 which are consecutively arranged. Therefore, the

contents of the low resolution video data obtained by  
decoding the low resolution data arranged in a carton are  
the same as those of the main track video data obtained  
by decoding the main track data in the same carton except  
5 for their resolutions.

[0083]

Besides the video data, the main track data can  
contain audio data associated with the video data. If  
the main track data contain both the video data and the  
10 audio data, for example, as shown in Fig. 2, the video  
data for a predetermined amount of data or a  
predetermined period of reproducing time and the audio  
data associated with the video data are arranged in  
combination.

15 [0084]

As the video data contained in the main track data  
in this case, for example, video data at a bit rate of 25  
Mbps (Mega bits per second), in which one GOP (Group of  
Pictures) is formed by 15 frames, can be used. As the  
20 audio data contained in the main track data in this case,  
for example, 4-channel audio data at a total bit rate of  
3 Mbps, which is 16-bit quantized at a sampling rate of  
48 kHz, can be used. Furthermore, as the low resolution  
data, for example, data obtained by JPEG-encoding video  
25 data of 256 by 192 pixels can be used.

[0085]

If the low resolution data are obtained by JPEG-  
encoding video data as described above, the low  
resolution decoder 5 shown in Fig. 1 is configured with a  
30 JPEG decoder for JPEG decoding.

[0086]

In addition to the low resolution data and the main track data, the time code of the video data, which is obtained by decoding the low resolution data and the main track data, the meta data in which predetermined information is arranged, and the like can be contained in the carton. In the meta data, it is possible to provide not only arbitrary information for a user but also a recording start position of the main track data in the carton and the information for the structure of GOP of the video data contained in the main track data. In the example shown in Fig. 2, the time code and the meta data are arranged together with the low resolution data. More specifically, assuming that a combination of the low resolution data, the time code and the meta data is referred to as a tag, the tag is situated at the head of the carton (the position on the optical disc 1 that is first read out) followed by the main track data. Therefore, in a case where the carton recorded on the optical disc 1 is to be read out, the tag is first read out followed by the main track data.

[0087]

Assuming that a total bit rate of the meta data such as the time code as described above and the low resolution data is 2 Mbps, a bit rate of the data recorded on the optical disc 1 in units of carton shown in Fig. 2 is 30 (= 25 + 3 + 2) Mbps. Therefore, an optical disc having a recording rate of, for example, 35 Mbps or the like, which recording rate satisfactorily falls within the range of practical use, can be used as

the optical disc 1. It is apparent that the disc drive 2 has a performance of recording data at a recording rate of 35 Mbps or higher.

[0088]

5       The low resolution data are arranged at a position on the optical disc 1 separately from corresponding main track data. In addition, the low resolution data have a sufficiently low bit rate and a small amount of data as compared with the main track data. Therefore, since the  
10 low resolution data can be verified (verified if they are correctly recorded or not) when they are recorded on the optical disc 1, the low resolution data can be recorded with high reliability as compared with the main track data. The verification of the low resolution data will  
15 be described below with reference to Figs. 3 to 6.

[0089]

      If the low resolution data are recorded, for example, after the video data are encoded by a fixed encoding method such as JPEG as described above, the contents  
20 recorded on the optical disc 1 can be easily confirmed regardless of the encoding method employed for the main track data. More specifically, in this case, a device capable of performing at least JPEG decoding can decode the low resolution data even if it cannot decode the main  
25 track data. Accordingly, the contents recorded on the optical disc 1 can be confirmed.

[0090]

      As described above, since not only the main track data but also the low resolution data corresponding to  
30 the video data of the main track data but having a

smaller amount of data are recorded on the optical disc 1, the low resolution data can be read out together with the main track data from the optical disc 1. Therefore, for example, if an error occurs in the main track data, error  
5 concealment can be performed by using the low resolution data so as to prevent real time playback (real time reproduction) from being interrupted. Moreover, in a case where only the main track data are read out from the optical disc 1, the low resolution data having a smaller  
10 amount of data are immediately read out so as to be reproduced even if, for example, the main track data fails to be read out too late for real time playback. As a result, the real time playback can be prevented from being interrupted.

15 [0091]

Furthermore, for example, in a case where high-speed playback (so-called shuttle playback) whose reproduction speed is higher than a normal reproduction speed is performed, the low resolution data which can be  
20 advantageously decoded within a shorter period of time are used instead of the main track data that require a longer time for decoding. As a result, the number of images that can be displayed in the high-speed playback, that is, the amount of information provided for a user  
25 can be increased.

[0092]

As described above, the main track data may contain the audio data in addition to the video data in some cases. In this embodiment, however, a description of the  
30 process of the audio data is herein omitted for



simplification of the description. Although a pattern is described as containing the entire main track data in the carton, an actual pattern has a fluctuation; for example, the main track video data corresponding to the low  
5 resolution data are sometimes recorded in the precedent or subsequent carton. Moreover, in the recording pattern on the actual disc, the data are not arranged with regularity as shown in Fig. 2 in some cases due to redundant data for demodulation or for error correction  
10 or for convenience of cluster control.

[0093]

Next, verification of the low resolution data, that is, the process for verifying if the low resolution data is correctly recorded in recording or not (hereinafter,  
15 also referred to as a verification process) will be described with reference to Figs. 3 to 6.

[0094]

Fig. 3 shows an exemplary inner configuration of the PCI interface 3 for the verification process. The buffer  
20 31 temporarily stores the low resolution data input from the low resolution encoder 17, which is to be recorded on the optical disc 1. A comparison section 32 compares the low resolution data stored in the buffer 31 and the low resolution data recorded on the optical disc by the disc  
25 drive 2 so as to be immediately read out from the optical disc 1 by the disc drive 2 with each other to determine if they are identical with each other. If it is determined that these data are not identical with each other as a result of the comparison, the low resolution  
30 data stored in the buffer 31 are recorded on the optical

disc 1 again.

[0095]

A procedure of the verification process is described with reference to a flowchart shown in Fig. 4. The  
5 verification process is executed each time the low resolution data are recorded on the optical disc 1.

[0096]

At a step S1, the PCI interface 3 stores the low resolution data, which are input from the low resolution  
10 encoder 17 so as to be recorded on the optical disc 1, in the buffer 31 while supplying the same low resolution data to the disc drive 2. The disc drive 2 records the low resolution data supplied from the PCI interface 3 on the optical disc 1.

15 [0097]

At a step S2, the system controller 10 determines whether there is excessive time before the start of writing next main track data or not. If it is determined that there is no excessive time before writing, that is,  
20 it is necessary to immediately write the next main track data, the verification process is terminated, expecting that the low resolution is recorded on the optical disc 1 without any abnormality.

[0098]

25 On the other hand, if it is determined that there is excessive time before writing at the step S2, the process proceeds to a step S3. At the step S3, the disc drive 2 reads out the low resolution data written on the optical disc 1 by the process at the step S1 so as to supply them  
30 to the comparison section 32 of the PCI interface 3.

Then, at a step S4, the comparison section 32 reads out the low resolution data stored in the buffer 31 and then compares the readout data with the low resolution data supplied from the disc drive 2 in the process at the step  
5 S3 so as to determine whether they are identical with each other or not. If it is determined that these data are identical with each other, the verification process is terminated because it means that the low resolution data are recorded on the optical disc 1 without any  
10 abnormality.

[0099]

On the other hand, if it is determined that these data are not identical with each other at the step S4, the process proceeds to a step S5. At the step S5, the  
15 comparison section 32 determines whether or not the low resolution data have been determined as not being identical with the same low resolution data read out from the buffer 31 for successive two or more times in the process at the step S4. If it is determined that the low  
20 resolution data have not been determined as not being identical for successive two or more times, the process returns to the step S1 so as to rewrite the same low resolution data on the optical disc 1. Then, the subsequent processes are repeated.

25 [0100]

If it is determined that the low resolution data have been determined as not being identical for successive two or more times at the step S5, the process proceeds to a step S6 because it is considered that a  
30 write error is caused by, for example, the presence of an

area on the optical disc 1 on which data can be hardly recorded. At the step S6, the disc drive 2 moves the pickup 2A in a radial direction of the optical disc 1 so that subsequently recorded data is recorded on a  
5 recording area separate from the actual recording area on the optical disc 1. Thereafter, the process returns to the step S1 followed by the subsequent steps. The description of the procedure of the verification process has been made above.

10 [0101]

By moving the pickup 2A as in the process at the step S6 described above, the subsequent main track data can be prevented from being written in the area that may be present on the optical disc 1, on which data can be  
15 hardly recorded. As a result, the reliability in writing the main track data can be improved.

[0102]

Fig. 5 shows a state in which the above-described verification process is executed in a case where a  
20 recording rate of the disc drive 2 on the optical disc 1 is not sufficiently high with respect to a bit rate of the data (the main track data, the low resolution data and the like) to be recorded on the optical disc 1. In the illustrated case, each of the low resolution data A  
25 and C is successfully written at the first writing, whereas the low resolution data B is written twice because the first writing is failed. In this case, since it is necessary to record the next main track data immediately after the second writing of the low  
30 resolution data B, it is not certain if the low

resolution data B is correctly written by the second writing.

[0103]

Fig. 6 shows a state in which the above-described  
5 verification process is executed in a case where a  
recording rate of the disc drive 2 on the optical disc 1  
is sufficiently high with respect to a bit rate of the  
data to be recorded on the optical disc 1. In the  
illustrated case, the low resolution data B is  
10 successfully written at the first writing, whereas the  
low resolution data A is successfully written at the  
third writing after the pickup 2A is moved because the  
first and second writings of the low resolution data A  
are failed.

15 [0104]

Next, a process of playing back a recorded video  
signal while encoding an input video signal so as to  
record it on the optical disc 1 (hereinafter, referred to  
as a time-shift playback process) will be described.

20 [0105]

As described above, the disc recording/reproducing  
device constituting the embodiment of the present  
invention encodes an input video signal at two types of  
resolution so that the resulting high bit-rate main track  
25 data and low bit-rate low resolution data are  
substantially simultaneously recorded on the optical disc  
1. A bit rate of the carton containing the main track  
data and the low resolution data is 30 Mbps.

[0106]

30 If a recording rate of the disc drive 2 is about 35

Mbps, an input video signal for two seconds is recorded every two seconds. However, since the actual time required to record the carton corresponding to the video signal for two seconds is only 1.68 seconds, an excessive  
5 0.32 second is generated every two seconds.

[0107]

In this case, as shown in Fig. 7, a plurality of tags, each containing the low resolution data, is read out at a time so as to reproduce the readout low  
10 resolution data within the excessive time generated by successively recording a plurality of cartons in the time-shift playback process. For example, five cartons corresponding to an input video signal for 10 seconds are successively recorded. Five tags are successively read  
15 out within the resulting excessive time of 1.6 (= 5 × 0.32) seconds so as to reproduce the low resolution data for 10 seconds of reproduction time.

[0108]

If a time difference between the time of the video  
20 signal being recorded and the reproduction time of a time-shift played back video signal (hereinafter, referred to as trace time) is short, a recording position and a readout position are close to each other. Therefore, few problems arise because the amount of  
25 movement of the pickup 2A for reading out the tag is small. In a case where the trace time is long, however, the recording position and the readout position are separate away from each other. Therefore, a moving distance of the pickup 2A for a reading out the tag  
30 becomes long so that the movement of the pickup 2A takes

longer time. Accordingly, if a unit of 5 tags is read out at a time as shown in Fig. 7, the trace time is limited to about 70 seconds, so that the time-shift playback is continuously performed without any  
5 interruptions.

[0109]

Next, a case where a recording rate of the disc drive 2 is about 70 Mbps will be considered. Also, in this case, an input video signal for two seconds is  
10 recorded every two seconds. However, since an actual amount of time required to record a carton corresponding to the video signal for two seconds is only 0.84 seconds, an excessive time of 1.16 seconds is generated every two seconds.

15 [0110]

In this case, the tag containing the low resolution data is read out so as to reproduce the readout low resolution data in the time-shift playback within the excessive time of 1.16 seconds that is generated by  
20 recording one carton, as shown in Fig. 8. In a case where the excessive time is as long as 1.16 seconds, as described above, there will be no problem if the amount of movement of the pickup 2A for reading out the tag becomes large. Therefore, even without limiting the  
25 trace time, for example, even if the trace time is set to be 100 seconds, the time-shift playback can be continuously performed without any interruptions.

[0111]

Moreover, in a case where the excessive time is as  
30 long as 1.16 seconds, as described above, only a small

amount of movement of the pickup 2A is required to read out the tag if the trace time is short (for example, one second). Thus, the main track data may be read out so as to be reproduced instead of reading out the recorded tag.

- 5 In such a case, an image provided for a user by the time-shift playback has high image quality.

[0112]

- Although the tag is read out after completion of recording in units of carton in the above description,  
10 the tag may be read out in response to a direction of time-shift playback given by a user even if the recording in units of carton is in progress. In such a manner, the quick-responsibility to a user's operation can be enhanced.

- 15 [0113]

- A pair of the pickups 2A may be provided for the disc drive 2 so that both of them are enabled to read out data. As a result, in a case where the recording rate of the disc drive 2 is about 35 Mbps, it is no longer  
20 necessary to limit the trace time. In a case where the recording rate of the disc drive 2 is about 70 Mbps, the time-shift playback using the main track data can be constantly performed regardless of the trace time.

[0114]

- 25 Next, a process of recording input video data on the optical disc 1 while externally transmitting the recorded video data through, for example, a LAN (Local Area Network) (hereinafter, this process is referred to as an upload process) will be described.

- 30 [0115]



The upload process is in common with the above-described time-shift playback process in that the low resolution data are read out from the optical disc 1 within the excessive time generated after each recording of the carton containing the main track data and the low resolution data on the optical disc 1. In the time-shift playback process, however, the read out low resolution data are reproduced at single speed, that is, processed at a constant speed. On the other hand, in the upload process, the read out low resolution data are communicated through a predetermined network or the like. Therefore, unlike the time-shift playback process, the amount of time required to transmit a fixed amount of low resolution data is not necessarily fixed, depending on the busyness or congestion of the network and the like.

[0116]

Fig. 9 shows an exemplary inner configuration of the PCI interface 3 for the upload process. The buffer 31 is used to temporarily store the low resolution data input from the low resolution encoder 17 so as to be recorded on the optical disc 1 and to store the low resolution data read out from the optical disc 1 by the disc drive 2 so as to be transmitted by the transmission section 18. In the upload process, if the low resolution data to be transmitted are present in the buffer 31 for recording, the low resolution data are read out so as to be transmitted. On the other hand, if the low resolution data to be transmitted are not present in the buffer 31, the low resolution data to be transmitted are read out from the optical disc 1 so as to be stored in the buffer

31. Then, the low resolution data are read out from the buffer 31 so as to be transmitted.

[0117]

Fig. 10 shows an example of the upload process,  
5 assuming that three low resolution data are successively read out from the optical disc 1 for each time.

[0118]

In the illustrated case, since the 0th to third low resolution data to be transmitted are present in the  
10 buffer 31 at the time of transmission, these low resolution data are not read out from the optical disc 1, whereas the low resolution data present in the buffer 31 are transmitted. However, since a transmission speed of these low resolution data is low due to a status of the  
15 network or the like, the fourth low resolution data is no longer present in the buffer 31 when the fourth low resolution data is to be transmitted, whereas the eighth to tenth low resolution data are stored therein. Accordingly, the fourth to sixth low resolution data are  
20 read out from the optical disc 1 to be stored in the buffer 31 for the transmission.

[0119]

If a transmission speed of the fourth and all the low resolution data that follow is improved, up to the  
25 seventh low resolution data are read out from the optical disc 1. For the eighth and all the low resolution data that follow, however, the readout of these low resolution data from the optical disc 1 is omitted because the low resolution data stored in the buffer 31 for recording  
30 still remain at the time of transmission. Therefore, the

low resolution data stored in the buffer 31 are used for transmission.

[0120]

The upload process is realized by executing in  
5 parallel a writing process of writing the low resolution data on the optical disc 1 and a transmission process of externally transmitting the low resolution data. First, one of these processes, that is, the writing process, will be described with reference to a flowchart shown in  
10 Fig. 11.

[0121]

At a step S11, the PCI interface 3 sets an invalid value -1 to a register reg[], which indicates a carton number of data stored in the buffer 31 in the arrangement  
15 of the same size as that of the buffer 31, so as to clear the register. The PCI interface 3 sets a frequency limit value mf0 to a counter mf for limiting a readout frequency. Herein, the frequency limit value mf0 may be automatically set in accordance with a communication  
20 speed as shown in Fig. 15 or may be arbitrarily set by a user.

[0122]

Moreover, at the step S11, the PCI interface 3 sets kr indicating a carton number of the last written data to  
25  $+\infty$  and kw indicating the last readout data to 0.

[0123]

At a step S12, the PCI interface 31 waits until data for one carton are stored in the buffer 31. After the data for one carton are stored in the buffer 31, the  
30 process proceeds to a step S13. At the step S13, the PCI

interface 3 outputs the data for one carton stored in the buffer 31 to the disc drive 2. The disc drive 2 records the input data for one carton to the optical disc 1.

[0124]

5       At a step S14, the PCI interface 3 determines whether the data for one carton that are stored in the buffer 31 are used shortly or not. If it is determined that the data are used shortly, the data for one carton are not erased but kept in the buffer 31. The process at  
10 the step S14 will be described with reference to a flowchart shown in Fig. 12.

[0125]

At a step 21, it is determined whether data, which are different from that previously written on the optical  
15 disc 1 and being still stored in the buffer 31, are read out or not. If it is determined that the different data are read out, the data stored in the buffer 31 are abandoned. Then, the process returns to a step S15 in Fig. 11.

20 [0126]

If it is determined that the data different from the data stored in the buffer 31 are not read out at the step S21, the process proceeds to a step S22. At the step S22, it is determined whether the data still stored in the  
25 buffer 31 are read out or not. If it is determined that the data are read out, the process proceeds to a step S23. At the step S23, it is determined whether a conditional expression  $kt < kw < kt + 10$  is satisfied or not. If it is determined that the conditional expression is  
30 satisfied, the process returns to the step S15 in Fig. 11.

In this conditional expression,  $kt$  is a carton number of the data being transmitted.

[0127]

If it is determined that the conditional expression  
5  $kt < kw < kt + 10$  is not satisfied at the step S23, the process proceeds to a step S24. At the step S24, the data still stored in the buffer 31 are further kept in the buffer 31, and  $kw$  is set to the register  $reg[kw\%10]$ . The process returns to the step S15 in Fig. 11.

10 [0128]

At the step S15 in Fig. 11, the PCI interface 3 increments the count  $mf$  by 1. At a subsequent step S16, the PCI interface 3 determines whether the buffer 31 is void or not. After the determination, the process  
15 proceeds to a step S17. At the step S17, the data are duly read out from the optical disc 1. A process at the step S17 is described with reference to a flowchart shown in Fig. 13.

[0129]

20 At a step S31, it is determined whether all conditional expressions  $kr - kt < kr0$ ,  $kt > kw - dt0$  and  $mf > mf0$  are satisfied or not. In these conditional expressions,  $kr0$  is a value of the exhaustion limit of the buffer 31. This value may be automatically set in  
25 accordance with a communication speed or may be arbitrarily set by a user. Moreover,  $dt0$  is a set value of the trace time.

[0130]

If it is determined that at least one of the  
30 conditional expressions is not satisfied, the process

returns to a step S18 in Fig. 11. On the other hand, if it is determined that all the conditional expressions are satisfied, the process proceeds to a step S32. At the step S32, it is determined whether an image reproduction  
5 mode is set (pb = ture) or not and whether the trace time is equal to or lower than the limit value dt0 or not.

[0131]

At a step S33, if it is determined that a desired carton is not yet written (that is, data to be read out  
10 are not yet recorded) or there are data being used or unused, the process returns to the step S18 in Fig. 11. On the other hand, if it is determined that the desired carton is not unwritten and there are no data being used or unused, the process proceeds to a step S34.

15 [0132]

At the step S34, it is determined whether the data to be read out from the optical disc 1 are stored in the buffer 31 or not. If it is determined that the data are stored in the buffer 31, the following processes at steps  
20 S35 and S36 are skipped. If it is determined that the data are not stored in the buffer 31, the process proceeds to the step S35. At the step S35, data for one carton are read out. However, if f = 0 is established, only the tag is read out. At the step S36, the counter  
25 mf is reset to 0. At a step S37, the register reg [k%10] is reset to kr (= K). The counter mf is reset to 0.

[0133]

If the number of times repeating the steps S33 to S38 is smaller than cr0 at a step S38, the process  
30 returns to the step S33 so as to repeat the subsequent

processes. If the number of times repeating the steps S33 to S38 reaches cr0, the process returns to the step S18 in Fig. 11.

[0134]

5       At a step S18 in Fig. 11, the PCI interface 3 determines whether the data for one carton are stored in the buffer 31 or not. If it is determined that the data for one carton are not stored therein, the process returns to the step S13 so as to repeat the subsequent  
10 processes. If it is determined that the data for one carton are stored therein at the step S18, the process proceeds to a step S19 where the verification process is executed if there is any excessive time. Thereafter, the process returns to the step S12 so as to repeat the  
15 subsequent processes. The writing process, which corresponds to one of the processes for realizing the upload process, has been described above.

[0135]

20       The transmission process, which corresponds to the other one of the processes for realizing the upload process, will now be described with reference to a flowchart shown in Fig. 14. At a step S41, the PCI interface 3 sets kt indicating a carton number of the low resolution data being transmitted to target -1 while  
25 setting the last readout carton number kr to kt. At a step S42, the PCI interface 3 determines that two conditions, that is, data are being written and the same data are being read out, are satisfied or not. If it is determined that any one of the conditions is not  
30 satisfied, the process proceeds to a step S43 where all

the register reg [] is cleared (an invalid value -1 is set). If it is determined that both of the conditions are satisfied, the process proceeds to a step S44 where the register reg [] is refreshed (if a value other than  
5 kt + 1 to kt + 10 is set, the set value is replaced by 0).  
[0136]

At a step S45, the PCI interface 3 waits until a conditional expression  $kt < kr$  is satisfied. If it is determined that the conditional expression is satisfied,  
10 the process proceeds to a step S46. At the step S46, the PCI interface 3 increments kt by 1. At a step S47, the PCI interface 3 supplies the low resolution data having the current number of kt to the transmission section 18. The transmission section 18 transmits the supplied low  
15 resolution data having the current number of kt. Thereafter, the process returns to the step S45 so as to repeat the subsequent processes. The transmission process, which corresponds to the other one of the processes for realizing the upload process, has been  
20 described.  
[0137]

Next, a process in high-speed playback (so-called shuttle playback) of playing back data at a higher speed than a normal reproduction speed (single speed) will be  
25 described with reference to Figs. 16 to 21.  
[0138]

Fig. 16 shows high-speed playback performed by a conventional DVD player or the like. In the conventional case, it is common to instantaneously increase  
30 reproduction speed from single speed to display images



while skipping some images in a similar way to show picture cards in the high-speed play back; that is, a set of the number of images corresponding to the reproduction speed are extracted so as to be displayed as stationary  
5 images for each certain period of time, in the high-speed playback.

[0139]

On the other hand, in the disc recording/reproducing device according to this embodiment, the main track data  
10 are reproduced in normal playback, whereas the low resolution data are reproduced in high-speed playback. Instead of instantaneously changing the reproduction speed in the high-speed playback, the reproduction speed is gradually changed at a constant acceleration as shown  
15 in Fig. 17. The accelerated reproduction speed is calculated in a predetermined period. In a state where the reproduction speed is  $n$ -x speed, a screen is horizontally divided into  $n$ . The areas obtained by the division are made to partially display different frames  
20 of the low resolution data, respectively, so as to allow a user to intuitively know the current reproduction speed.

[0140]

The high-speed playback will be more specifically described. If high-speed playback (for example, 8-x  
25 speed playback (8-x speed reproduction)) is directed in a state of normal playback where the main track data is displayed on a screen, the reproduction speed gradually changes from single speed to 8-x speed. When the reproduction speed reaches double speed, for example, the  
30 screen is horizontally divided in two. Two different

frames of the low resolution data are partially displayed  
in the respective two areas obtained by the division.  
Similarly, for example, when the reproduction speed  
reaches triple speed, the screen is horizontally divided  
5 in three. Three different frames of the low resolution  
data are displayed partially in the respective three  
areas obtained by the division. When the reproduction  
speed ultimately reaches 8-x speed, the screen is  
horizontally divided into eight. Eight different frames  
10 of the low resolution data are partially displayed in the  
respective eight areas obtained by the division.

[0141]

If normal playback is directed by a user while the  
high-speed playback is in progress, the reproduction  
15 speed of the high-speed playback using the low resolution  
data is gradually lowered to single speed at a constant  
acceleration in the reverse manner to that described  
above, thereby switching the reproduction mode to single-  
speed playback of the main track data. For example, Fig.  
20 18 shows a state where a reproduction mode returns from  
8-x high-speed playback to normal playback.

[0142]

In 8-x high-speed playback, the screen is  
horizontally divided into 8. Eight different frames of  
25 the low resolution data are partially displayed in the  
respective eight areas obtained by the division. If  
normal playback is directed by a user in this state, the  
reproduction speed is gradually lowered at a constant  
deceleration corresponding to acceleration to 7-x speed,  
30 6-x speed, 5-x speed, 4-x speed, triple speed, double

speed and single speed. Meanwhile, for example, when the reproduction speed is lowered to 5-x speed, the screen is horizontally divided into 5. Five different frames of the low resolution data are partially displayed in the  
5    respective areas obtained by the division. Similarly, when the reproduction speed is lowered to double speed, the screen is horizontally divided into two, and two different frames of the low resolution data are partially displayed in the respective two areas obtained by the  
10   division.

[0143]

    In a case where the reproduction speed being accelerated is calculated in a predetermined period in the high-speed playback, the calculated reproduction  
15   speed being accelerated sometimes includes a decimal fraction, depending on the predetermined period or a value of the acceleration. In such a case, the division of the display screen will be more complicated. Such a case will be described with reference to Fig. 19.

20   [0144]

    For example, Fig. 19 shows an example in which high-speed playback at 4-x speed is performed where a period for calculating the reproduction speed being accelerated is set to a time period allowing a frame to be switched  
25   in normal playback (in a case of NTSC, 1/30 seconds), a reproduction speed  $v$  is 1 at timing  $t = 0$ , and an acceleration of the reproduction speed is 0.4 frames for each of the periods.

[0145]

30      In this case, at the timing  $t = 0, 1, 2, 3, \dots, 8,$

the reproduction speed  $v$  is calculated as 1, 1.4, 1.8,  
2.2, ..., 4.2.

[0146]

At the timing  $t = 0$ , the 0th frame is displayed on  
5 the screen.

[0147]

At the timing  $t = 1$ , a part of the first frame is  
displayed in an area having a height of 0.714 ( $= 1/1.4$ )  
obtained by division, where the total height of the  
10 screen is 1. In an area therebelow, a part of the second  
frame is displayed.

[0148]

At the timing  $t = 2$ , a part of the third frame is  
displayed in an area having a height of 0.556 ( $= 1/1.8$ )  
15 obtained by division, where the total height of the  
screen is 1. A part of the second frame is displayed in  
an area thereabove having a height obtained by  $0.6 \times$  the  
height 0.556, where 0.6 corresponds to a fraction of the  
moving distance  $l = 2.4$  with respect to 3, whereas a part  
20 of the fourth frame is displayed in an area therebelow.

[0149]

At the timing  $t = 3$ , a part of the fifth frame is  
displayed in an area having a height of 0.455 ( $= 1/2.2$ )  
obtained by division where the total height of the screen  
25 is 1. A part of the fourth frame is displayed in an area  
thereabove having a height obtained by  $0.8 \times$  the height  
0.455, where 0.8 corresponds to a fraction of the moving  
distance  $l = 4.2$  with respect to 5, whereas a part of the  
sixth frame is displayed in an area therebelow.

30 [0150]

At the timing  $t = 4$ , a part of the seventh frame is displayed in an area having a height of  $0.385 (= 1 / 2.6)$  obtained by division, where the total height of the screen is 1. A part of the sixth frame is displayed in  
5 an area thereabove having a height obtained by  $0.6 \times$  the height  $0.385$ , where  $0.6$  corresponds to a fraction of the moving distance  $l = 6.4$  with respect to  $7$ , whereas a part of the eighth frame is displayed in an area therebelow.  
[0151]

10 For the following timings, the screen display is performed in a similar manner in accordance with the reproduction speed being accelerated.  
[0152]

At the timing  $t = 8$ , the reproduction speed reaches  
15 a target speed. At this time, an odd display area is generated by the division of the screen as shown in Fig. 20 on the left. If the high-speed playback is continued while such an odd display area is present, the appearance is degraded. In addition, the process for display  
20 becomes troublesome. Therefore, as shown in Fig. 20 on the right, the division of the screen is adjusted so as not to generate any odd areas. In the illustrated case, the screen is horizontally divided into four for display.  
[0153]

25 On the contrary, in a case where the reproduction speed is lowered to single speed, for example, in response to a direction of normal playback by a user, from a state where the division of the screen is adjusted so as not to generate any odd areas as shown in Fig. 20  
30 on the right, the adjustment is cancelled at the start of

deceleration, as shown in Fig. 21. In this manner, the appearance can be prevented from being degraded as compared with a case where the adjustment is not cancelled at the start of deceleration but the adjustment is performed again for an odd area, which is generated by the division of the screen when the reproduction speed returns to single speed.

[0154]

The above-described procedure of high-speed playback is summarized as shown in a flowchart of Fig. 22. At a step S51, the system controller 10 sets a target speed (for example, 4-x speed) in the high-speed playback in response to the manipulation of the remote commander 21 by a user. Then, the system controller 10 starts counting time after initializing the timing  $t$  shown in Fig. 19 to 0 while initializing various parameters  $v$ ,  $l$  and the like.

[0155]

At a step S52, the system controller 10 calculates various parameters (a reproduction speed  $v$ , a moving distance  $l$ , a height of an area obtained by horizontally dividing a screen, and the like) corresponding to the timing  $t$ . The system controller 10 outputs the height of the area obtained by horizontally dividing the screen to the OSD section 8 so as to direct the generation of the screen for the high-speed playback. At a step S53, in response to the direction from the system controller 10, the OSD section 8 generates video data whose different frames are partially displayed in the areas obtained by horizontally dividing the screen in accordance with the

reproduction speed and then outputs the video data to the later stage.

[0156]

At a step S54, the system controller 10 determines  
5 whether the reproduction speed  $v$  calculated in the process at the step S52 has reached the target speed set in the process at the step S51 or not. If it is determined that the calculated reproduction speed  $v$  has not reached the target speed, the process returns to the  
10 step S51 so as to repeat the subsequent processes.

[0157]

Then, at the step S54, if it is determined that the reproduction speed  $v$  calculated in the process at the step S52 has reached the target speed set in the process  
15 at the step S51, the process proceeds to a step S55. At the step S55, in response to the direction from the system controller 10, the OSD section 8 adjusts an odd area present in the video data generated by the process at the step S53 so as to output the video data to the  
20 later stage.

[0158]

Thereafter, the process returns to the step S53 so as to repeat the subsequent processes until termination of the high-speed playback is directed. The high-speed  
25 playback process has been described above.

[0159]

Although the reproducing of video data has been described in the above embodiment, the present invention is also applicable to, for example, reproducing audio  
30 data.

[0160]

Although the low resolution data obtained by degrading the resolution of the main track data are used as the low resolution data in the above embodiment, it is  
5 also possible to use low resolution data obtained by, for example, reducing the number of bits allocated to pixels constituting the main track data as the low resolution data.

[0161]

10 Furthermore, although the JPEG system is used as the encoding method for the low resolution data in the above embodiment, the encoding method used for the low resolution data is not limited to the JPEG method.

[0162]

15 Although the MPEG system is used as the encode method for the main track data in the above embodiment, the encoding method for the main track data is not limited to the MPEG system.

[0163]

20 Although the encoded video data are used for both the low resolution data and the main track data in the above embodiment, the video data without being encoded can be used as the low resolution data and the main track data.

25 [0164]

Although the length of the carton is set to about 2 seconds in the above embodiment, the length of the carton is not limited thereto. For example, by reducing the length of the carton, a track jump from the low  
30 resolution data to the main track data can be reduced or



omitted so as to further improve the response. On the other hand, by increasing the length of the carton, it becomes easy to read out the low resolution data in advance for storage. In this case, since it is not  
5 necessary to read out the low resolution data at each start of reproduction, the response can be further improved.

[0165]

A series of the above-described processes may be  
10 executed either by a hardware or by a software. In a case where the series of the processes are executed by a software, the software is installed from a recording medium to a computer, in which a program constituting the software is incorporated into a dedicated hardware, or,  
15 for example, to a general-purpose personal computer capable of executing various functions by installation of various programs.

[0166]

Throughout the specification, the steps describing  
20 the program recorded on a recording medium include not only the processes performed in time series in accordance with the described order but also the processes executed in parallel or individually without being necessarily processed in time series.

25 [0167]

Throughout the specification, the system means the entire device configured with a plurality of devices.